SOLECTEK

Jonathon Cheah
Solectek Corporation

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

August 2, 1996

Mr. William Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

DOCKET FILE COPY ORIGINAL

Re ET Docket No 96-102
NPRM 96-193 (May 6, 1996)

Dear Mr. Caton

Enclosed are an original and four copies of the reply comments of Solectek Corporation in response to the above Notice of Proposed Rulemaking by the Commission.

Please address any questions to the undersigned

Dr. Jonathon Cheah.,
Vice President of Engineering.
Solectek Corporation

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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	NPRM 96-193 (May 6, 1996)
Amendment of the Commission 's Rules to	)	ET Docket No. 96-102
Provide for Unlicensed NII/SUPERNet	)	RM-8648
Operations in the 5 GHz Frequency Range	)	RM-8653
	)	

REPLY COMMENTS OF SOLECTEK CORPORATION

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Dated: August 2, 1996

SUMMARY

Solectek Corporation strongly supports the Commission's NII/Supernet proposal for establishing 350 megahertz of spectrum at 5.15-5.35 GHz and 5.725-5.875 Ghz for use by unlicensed equipment.

The comments submitted to the Commission on this NPRM have not addressed the long range community network requirements sufficiently to distinguish the distinctive differences in the technical requirements for both indoor and outdoor devices.

Based on Solectek Corporation's extensive experience in providing long distance interbuilding wireless data links to a wide cross section of digital data traffic users, it is clear that the interference potentials presented by both wireless indoor networks and wireless outdoor community networks are different. In addition, the propagation strategy utilized by these devices is also vastly dissimilar. The benefits to the proposed users of the bands and the incumbent users will be better served by establishing separate indoor and outdoor device classifications that allow maximum protection of the incumbent operations of the bands without imposing undue constraints on the promise of advancement in wireless technology in these bands.

Solectek Corporation urges the Commission to consider the following technical recommendations in regards to long range community networks:

- That the Commission adopts a separate classification and different technical requirements for indoor intentional radiators and outdoor intentional radiators for NII/SUPERNet devices operating at 5.15-5.35 Ghz and 5.725-5.875 Ghz.
- That operating within the 5.15-5.35 Ghz band, the indoor intentional radiators shall not exceed peak EIRP of -10 dBW. Outdoor intentional radiators shall not exceed peak EIRP of -10 dBW and the outdoor antenna gain shall be more than 20 dBi in both vertical and horizontal planes or less than 8 degree solid angle at 1 dB point of the beam width. This is to ensure only high gain antennas are used by the outdoor devices.
- That operating within the 5.725-5.875 Ghz band, the indoor intentional radiators shall not exceed peak EIRP of 6 dBW. Outdoor intentional radiators shall not exceed peak output power of 0 dBW and the antenna gain shall be more than 20 dBi in both vertical and horizontal planes or less than 8 degrees solid angle at 1 dB point of the beam width.
- That the NII/SUPERnet devices shall ensure the integrity of the device in the spirit of Section 15.203 of the Commission's rules and the clarification presented in the proposed Section 15.204 rule[1]. The device shall provide integrity of the constituent components by either mechanical means, such as unique connectors or electrical means such as automatic electronic identification. Assurance of device integrity by "professional installers" shall not be permitted.

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[1] ET Docket No. 96-8, Februrary 5, 1996, paragraph 44 and Appendix B.

Herein, Solectek Corporation presents the supporting justifications to substantiate the validity of the recommendations in terms of electromagnetic compatibility with the incumbent operations in the proposed NII/SUPERNet bands and the greater technical flexibility in design and operation of the long range community network products.

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REPLY COMMENTS OF SOLECTEK CORPORATION

Solectek Corporation submits its reply comments in response the Commission's Notice of Proposed Rulemaking as referenced above, in regards to long range community networks. Solectek Corporation recognizes the different application environments for the indoor devices and the outdoor devices. For the best public interest, the necessary technical requirements for these two dissimilar devices must be different in order to serve both areas of technological advancement without undue hindrance and bias, and without unacceptable interference to the incumbent users of the frequency bands. It is Solectek Corporation's intention to identify the differences in the propagation strategy of the indoor and the outdoor devices, and at the same time, to ensure a minimum acceptable level of potential interference to the like-kind unlicensed devices and to the incumbent users of these frequency bands.

Solectek Corporation strongly supports the Commission's NII/SUPERnet proposal in making available 350 Mhz of spectrum at 5.15-5.35 Ghz and 5.725-5.875 Ghz for use by unlicensed equipment.

I. INTRODUCTION

Solectek Corporation has extensive experience in providing high speed digital data wireless products capable of up to 25 mile distance for interbuilding connections operating on 2.4000-2.4835 Ghz band. These products are authorized to operate under Section 15.247 of the Commission's rules without a waiver on Section 15.247 subpart (b) with 1 Watt output power and 6 dBi antenna gain limit[2]. These products are also compliant with the Section 15.203 rule without the need of professional installers to ensure the integrity of the constituents of the products when installed. This is achieved by using an electronic safeguard so that the system shuts down when non-certified antennas are attached.

It is clear from a link margin analysis standpoint that EIRP of the transmitter has to be matched with the G/T of the receiver for a given desirable distance. Given that the EIRP of the transmitter is fixed by regulatory limits, one can optimize on the G/T for the necessary link margin to achieve the distance goal. The resultant effect is a reduction in the contribution to the noise and interference within the electromagnetic medium. Contrary to claims[3] that long range wireless links are not possible without a relaxation of the Section 15.247 subpart (b) of

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[2] The Commission's waiver under file: 31030/EQU/4-2-7 1300C2, June 18, 1996 to WMC, Cylink and Atlantic Communication Sciences, Inc.

[3] Reply coments to ET Dockets No. 96-8, Februrary 5 1996, from Cylink Corporation and Western Multiplex Corporation.

the Commission's rules, distances further than 25 miles are evidently possible using a simple link analysis.

Solectek Corporation has proven that such an analysis held true in its 25 mile long range product line and that these products have successfully provided high speed data links in point to point and point to multipoint configurations to many segments of the high speed data traffic users, such as fortune 1000 companies, federal, state and local governments, maritime research organizations and amusement parks, schools and universities, ISP (Internet Service Providers) and other Internet - information superhighway related providers. There are many other applications where quick deployment of unlicensed wireless links are an indispensable means of communication. For example, Solectek products are used in offshore oil rigs with over-water path distances from 1 to over 10 miles in multipoint network configurations.

Thus, using the similar analytical techniques, and benefiting from real world product experience, Solectek Corporation presents the justification of its recommendations contained herein.

II. QUALIFICATIONS

The reply comments presented herein were prepared by Jonathon Y. C. Cheah, and he is solely responsible for the accuracy of the contents. Jonathon Y. C. Cheah was one of the founding members of IEEE802.11 standard, and he had participated in circuit and systems designs, as well as served in supervisory roles in the development of several relevant technologies related to these NPRM comments. These technologies are: Roaming and interbuilding wireless link products under Section 15.247 of the Commission's rules, IS-19, IS-54, IS-55, IS-95, CDPD, DBS (DirecTV) and VSAT.

III. METHOD OF INDOOR AND OUTDOOR DEVICE CLASSIFICATIONS

Classification of indoor and outdoor devices operating in the NII/SUPERnet bands can draw parallels from Section 15 Subpart (B) of the commission's rules where radiation limits for Section 15.107 and Section 15.109 of the Commission's rules are classified with respect to Class A and Class B non-intentional radiator devices.

In the case of NII/SUPERnet, indoor devices are Class A intentional radiators and outdoor devices are Class B intentional radiators. Such a distinction opens ways to separate the technical requirements best suited to promote maximum technical advancement possibilities.

IV. CHARACTERISTICS OF INDOOR AND OUTDOOR DEVICES

Indoor devices are defined as devices that are used within an enclosed building or dwelling which is not used as a radome structure. Outdoor devices are defined as devices that are deployed external to a building. Outdoor devices must be installed in a non-portable manner by means of a secure attachment to a permanent fixture of a building or structure.

Indoor devices :

Indoor devices are typified by the wireless LAN "roaming products" that form peer to peer ad hoc networks or through the use of fixed network of "access points" to establish mobile connections within a planned coverage area. Indoor application has a number of distinctive characteristics. It needs low gain omni directional antenna for transmission as the actual direction of the target receiver is normally unknown to the transmitter. It relies on multipath scattering propagation for its signal transmission. The propagation path is mainly a Rayleigh fading channel or at best, a poor Ricean fading channel. The device is normally mobile, without a permanent fixed location and therefore it requires an uncoordinated channel access strategy such as CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) or similar derivative methods such as "Listen before Talk" . The cumulative effects of the need for ad hoc network connectivity and the complex propagation nature of the spectrum utilization limit the known technical options to maximize spectrum usage efficiency. For instance, it is also not uncommon for device designers to intentionally de-sensitize the receiver so as to minimize false signal detection in an attempt to improve throughput performance.

It is essential that indoor devices from different manufacturers adopt a common collaborating standard with a harmonized network access strategy in order to coexist. This fact has received widespread agreement from all sectors of this industry. However, mandating a "listen before talk" as a necessary element of a standard would prevent future development of suitable access strategies. Indeed, such an analysis has been argued within the current IEEE802.11 standard committee for many years and that "listen before talk" as a function of "Clear Channel Assessment" within IEEE802.11 standard is not strictly applied.

It is easy to realize that a network connection using such devices has a natural tendency to raise the electromagnetic interference background content very rapidly as the network gets more over-the-air data traffic. The consensus approach of limiting the EIRP of these devices to a minimum is correctly applied. The reduced EIRP and the natural inability to improve receiver sensitivity due to false detection probability result in a smaller coverage area per device. In this way, the total over the air data traffic capacity in terms of bits/second/unit-area is increased. Nevertheless, such wireless networks raise concerns over interference potentials because of inefficient spectrum utilization.

However, such concerns can be limited if the deployment of these devices are restricted within the confines of a building. At 5 Ghz, building materials also represent suitable barriers to electromagnetic radiation. Indeed, most wireless LAN applications are within a building. This is also borne out by the proponents of HIPERLAN which expects that more than 99% of all HIPERLAN usage will be indoors.

Thus, allowing 5.725-5.875 Ghz bands to have unlimited low antenna gains and broad antenna beam patterns would pose serious co-site coordination problems for outdoor applications. For example, an omni co-linear antenna array can easily have more than 15 dBi gain to cast a downward squint, pan-cake shape beam in a 360 degree azimuth coverage. In an unconfined radiating environment, such as the exteriors of a building, it can present a significant challenge to subsequent like-kind wireless network installations in the vicinity.

Similarly, it would be shown in the analysis that low antenna gain for 5.15-5.35 Ghz band will also pose significant interference potential to satellite feeder links. Low antenna gain and therefore broader antenna beam width will significantly promote multipath scattering propagation effects. As a result, successful interference coordination will also be seriously jeopardized.

Outdoor devices:

Outdoor devices are typified by fixed location installations. Although it is true that there are many outdoor mobile device applications, such as parking lot data entry for trucks or rental cars check-in, it is clear that the 5.1 and 5.7 Ghz bands are less attractive for these usage because of propagation reasons.

Fixed outdoor devices have fixed target connection points. Its propagation environment is largely benign and closely akin to Added-White-Gaussian-Noise (AWGN) Channel when a highly focused antenna beam is used. Thus, it can use a multitude of more efficient connection oriented protocols. It has the freedom to maximize the receiver sensitivity as a means to attain greater distance capability and therefore greater spectrum utilization efficiency without increasing spectrum interference level. Furthermore it can make use of highly focused antenna beam to achieve spatial isolation. Its interference potential is less, as its radiated area is limited and highly traceable. It is well known that in this type of channel characteristics, the radiated power flux density decreases by a propagation index of 2 or more with respect to distance. Furthermore, the interference potential is by its nature limited spatially.

As elucidated above, the need of a industry standard access protocol is less important. This is because interbuilding wireless network do not need ad hoc network connections. By its dedicated nature and its fixed physical location, more efficient connection protocols are possible.

In addition, by nature of the fixed point to point connectivity that requires a line of sight propagation path, the outdoor devices are installed inevitably on top of buildings or on higher elevations. Clearance for the Fresnel Zone ensures this assumption is true in most cases. In this way, the source of the maximum electromagnetic field intensity at the transmitter is further removed from areas where the mobile indoor devices are most likely to be present.

At 5.15-5.35 Ghz and 5.725-5.875 Ghz, antenna gain of greater than 20dBi is easily achievable both by a reflector antenna or phased array technology with acceptable dimensions. Thus, it is reasonable to restrict the antenna to no less than 20 dBi gain. It is clear that the use of a high gain antenna improves spectrum utilization efficiency in terms of bits/second/unit-area capacity.

Typical applications for the outdoor devices are to provide high speed data links among buildings. The needs for such deployment have been evident. It is necessary to point out the increase of data bandwidth requirements spurred by the advent of high speed personal computers and the wide spread acceptance of Internet connectivity, has compounded the "last mile problem" of existing telecommunication industry's ability to provide communication linkage to buildings. There is an enormous demands for this bandwidth deficiency to be corrected. The availability of the NII/SUPERnet outdoor devices that have the capability to carry tens of megahertz of data bandwidth is certainly a valuable addition to the solution set of this problem. Successful deployment of long range community networks will in fact significantly augment the scarce telecommunication underground infrastructure resource to meet the explosive demands on building to building data bandwidth requirements. In applications such as those use in offshore oil rigs and maritime operations, the long range community network is the only choice if the low data rate performance of satellite communication links are unacceptable.

It is the Commission's intention not to allow higher EIRP than -10 dBW at 5.15-5.35 Ghz band due to interference considerations. However, without a limitation on low antenna gain, it can be shown that outdoor usage of such devices would still present troublesome interference potentials. The Solectek Corporation's high gain antenna requirement recommendation in this band allows such interference concerns to be addressed equitably both in terms of protection of the mobile satellite feeder links, and to promote the advancement of high speed wireless link technology in the 5.15-5.35 Ghz band.

For the 5.725-5.875 Ghz band, the permission to use unrestricted antenna gain at 0 dBW transmit power poses a network co-site problem when high power omni-directional antennas or broad beam sectorial antennas are used. The result is a less efficient spectrum sharing per unit area. The need of broad antenna beams cannot be justified given that in the long range community network situation, the locations of the points of connection are known, and narrow beam antennas can serve the purpose without contributing to extraneous interference potential.

Summary:

- Because of the distinctive differences in the applications, the technical requirements for indoor and outdoor devices should be differentiated by a Class A indoor device and Class B outdoor device classifications.

- For outdoor devices, the use of low gain antennas prevents effective spectrum sharing in a community network. Antenna gain of no less 20 dBi with symmetrical vertical and horizontal beam profiles should be used to maintain spatial isolation, and to provide non scattering paths. This is also to allow optimization of receiver sensitivity.

V. INTERFERENCE POTENTIALS TO AERONAUTICAL AND SATELLITE SERVICES

The key concern of the long range community network operating in the 5.15-5.35 Ghz band is the potential interference to mobile satellite (MSS) feeder links. Additional concerns were expressed relating to leakage into Microwave Landing System ("MLS") operating on 5.00-5.15 Ghz.

Leakage into restricted bands has been successfully addressed by Section 15.209 of the Commission's rules for devices operating under Section 15.247 rules for sometime. Similar and suitable restriction requirements can be applied to address this concern. The Commission has proposed at least 50 dB or to the radiated emission limits set forth in Section 15.209 whichever is the lesser attenuation. This provision should safeguard undue interference into the adjacent bands.

Proposed mobile satellite feeder links such as that of Loral/QUALCOMM[4] operating on 5.1585 to 5.216 Ghz, are related to satellite downlink to gateway earth stations. Such stations track satellites with a pointing range of 360 degrees in azimuth and 5 to 90 degrees in elevation. The gateway antenna has a typical gain of 38.2 dBi in this band. At 90 degree elevation, the worst case receive signal strength per channel is -198.9 dBW with the worst case acceptable interference of $Eb/Io = 5.0$ dB.

Although, there are no rain and atmospheric multipath margins[5] specifically presented for these feeder links, undoubtedly, such link margins must have been implicitly reserved. This is especially true where the proposed low gazing angle is 5 degrees above horizon. Taking 0 degree C isotherm height of 5 Kilometers, for 35 mm/hr rain rate at 99.9 % link condition such as that in the State of Florida, the rain margin is about 2 dB. This is computed using the Crane[6] rain model which has been accepted by the Commission in the DirecTV DBS[7] link budget submission. Bearing in mind that if the feeder links were to deploy worldwide, then the worst case equivalent rain rate should be 64 mm/hr. These margins further re-enforce the interference immunity of the feeder links in clear sky. With rain on the downlink, the feeder link has an equivalent 55 Kilometer rain path under 0 degree C isotherm and the interfering source would also suffer equal attenuation index in terms of dB per Kilometer.

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[4] Globalstar system application, File No. 19-DSS-P-91(48) CSS 91-014. June 3, 1991.
[5] Bullington, K. "Radio propagaion fundamentals", BSTJ, Vol. 36, No.3.
[6] Crane, R.,"Prediction of attenuation by rain", IEEE Trans. comm vol. com-28, No. 9 1980.
[7] Application of Hughes Communications Galaxy, Inc, for minor modification of construction permit for its direct broadcast satellite system, received by FCC on July 15, 1991.

The following simple calculations show the interference potential of a 30 Mhz wide NII/SUPERnet signal carrying 25 Mega symbols per second signal with a 20% excess bandwidth under the recommendations in 5.15-5.35 Ghz band and its interference distance calculated using parameters from Loral/QUALCOMM link budget.

Specifically, in this simple analysis, the outdoor NII/SUPERnet devices is assumed to have a free space propagation path. The use of propagation index higher than 2 would have not changed the interference potential picture significantly. On the other hand, this calculation assumes a 90 degree elevation satellite feeder link receive signal strength. The use of 5 degree slant path loss for the satellite feeder link would not be appropriate. From the details of the Loral/QUALCOMM feeder link parameters submitted to the Commission, it is doubtful that the satellite feeder links can close the necessary link budgets at this gazing angle. Thus, the results shown here are a reasonable representation of the interference potentials that exist.

As it can be seen that without highly directional antennas to minimize the interference potentials, outdoor NII/SUPERnet devices may be detrimental to the viability of a typical mobile satellite feeder link.

Satellite feeder links	**L/C**	**L/S/C**	**NII/SUPERnet**	
Feeder link receive signal strength per channel:	-181.1	-198.9 dBW	NII/SUPERnet EIRP	-10 dBW
Antenna gain	38.2	38.2 dBi		
Interference margin	-6.9	-5 dB	Path loss to affect L/C case	127.7 dB
Maximum sidelobe gain	-20	-20 dB	Path loss to affect L/S/C case	135.8 dB
1.25 Mhz passband rejection of 30 Mhz signal	13.8	13.8 dB	Interference distance in L/C case	**7 miles**
Noise despreading capability (4.8 Kbps)		24.1 dB	Interference distance in L/S/C case	**18 miles**
Noise despreading capability (28.8 Kbps)	16.3			
Rain Margin at 5° gaze	2	2 dB		
Maximum tolerable interference level at the feeder station site:	-137.7	-145.8 dBW		

While this analysis concludes that there is a real interference potential to the Loral/QUALCOMM's satellite feeder downlink to the gateway stations if low antenna gain NII/SUPERnet outdoor devices are present, it does not support Loral/QUALCOMM's subsequent comments[8] concerning interference to the spacecraft receivers. Unless the frequency plan has changed from the original Loral/QUALCOMM's application[4], the satellite to gateway station frequency plan is very clearly presented throughout this Loral/QUALCOMM document, and is graphically illustrated in page 113 of the same document. The comments and the careful technical analyses on the NII/SUPERnet device interference to spacecraft receivers submitted by Loral/QUALCOMM[8] must be alluding to something new that is not in the public record. Indeed, if the spacecrafts have receivers in the 5.15-5.35 Ghz band, then there is a much more serious inter-spacecraft interference question.

It is also known within the Ku-band VSAT satellite communication industries for some years that the majority of the consumer tri-band vehicular speed radar detectors that operate on Ka-band radar signals emit significant pulsing interference in 11.7-11.85 Ghz portion of the Ku-band with respect to the typical VSAT downlink flux density. However, such interference is generally not discernible by Ku-band VSAT by virtue of the annular skirting fence or barrier commonly present around the earth stations. Although the fences and barriers are originally means of security against trespassers, they make co-existence of VSAT in gas stations and radar detectors possible. By similar deduction, mobile satellite feeder gateways can be

[8] ET Docket No. 96-102 Comments of L/Q Licensee, inc., received by FCC July 15 1996.

protected against the potentials of NII/SUPERnet interference by physical means. Furthermore, the highly directional beams of NII/SUPERnet devices and their fixed physical positions make offending interference easily traceable, and whereby interference coordination can take place easily.

VI. "Tragedy of the Commons"

It is essentially true that a 25 Mbits/sec signal will fit into a 30 Mhz bandwidth using a 1 bps/Hz modulation with a minimum of 20% excess bandwidth. Some excess bandwidth is necessary to overcome the infinite ISI (intersymbol interference) of a brickwall filter. However, it seriously limits the exploitation of the attributes of other less efficient modulation techniques such as those using orthogonal signal detection. The classification of indoor and outdoor devices resolves the "Tragedy of the Commons" concern. The choice of the modulation technique for the indoor devices should be part of the access etiquette consensus within the industry. For the outdoor devices, the spatial isolation afforded by the highly focused antenna beam side-steps this issue completely.

Thus, a minimum modulation efficiency requirement or a bandwidth channellization requirement may limit the innovation potentials in the use of the 5.15-5.35 and 5.725-5.875 Ghz bands.

VII. CONCLUSION

Solectek Corporation recommends the classification of indoor and outdoor devices operating in the NII/SUPERnet bands with separate technical requirements. Technical justifications are presented to address the concerns regarding electromagnetic compatibility. It is shown that limiting the outdoor devices to operate with high gain antennas allows the best spectrum utilization for these bands.

Respectfully submitted,

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By: ______________________

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Dated: August 2, 1996